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set to watch and control it those who do not know even the component elements of the stuff within!

I may be reproached with encroaching in these remarks, on the function of the library school. Why, all the better! We need these elements in all our training. But the apprentice course may do its share to turn the minds of its students to those forces which are re-molding the world to-day,—even libraries!

Our greatest difficulty, I fancy, will be in gaining for our ranks those young people whom we would wish to see enter them. Very briefly, it may be said that there are two reasons for this situation.

One is our own failure to insist on the high standing of our work. The other is a sordid and earthly condition of which you are all aware and of which I have not been asked to speak! I should like to suggest, albeit with some temerity, that the latter

reason is partly an outgrowth of the first. We might abandon the apologetic, the sentimental, the too-genteel attitude, translating our high talk into the language of the practical man. Conviction within, possibly, would lead to quicker acknowledgment from without.

Let me finish very quickly. Without wishing to assume too large and serious a task for the apprentice work of libraries, I believe sincerely that those of us who have the opportunity of forming this work are peculiarly fortunate, and also extremely responsible. In our selection of young people to enter library work we cannot be too discriminating. What we need in our profession, I fancy, is spontaneity, a quicker life, a capacity for growth. Our privilege, as I believe, is to give every opportunity for such growth. It is a question whether any education, however complete, can do more.

THE UTILIZATION OF PHOTOGRAPHIC METHODS IN LIBRARY RESEARCH WORK, WITH ESPECIAL REFERENCE TO THE NATURAL SCIENCES

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Photographic methods are no novelty in library research work and many rare manuscripts and incunabula have been reproduced photographically. It is our purpose to call attention to the possibility of making fuller and more frequent use of some of the newer photographic methods in library research work, particularly in the natural sciences and industrial work.

Photostat Used to Copy Books and Manuscripts

In recent years there have been placed on the market large cameras which take photographs by the light of a mercury vapor lamp directly on a roll of sensitized paper which after exposure is cut off and developed at once in the machine. These cameras are known by the trade names of

photostat, cameragraph, etc., and were originally devised for use in copying important legal documents, letters, drawings, plans, etc. Such a camera has proved so valuable in our work that we venture to give a few notes on the uses to which we have found it fitted.

We have used in our work the larger size photostat (No. 2), which is able to take a roll of paper 13 inches wide and can also use the narrower roll, 11 inches wide. It takes a photograph of a maximum length of $17\frac{1}{8}$ inches. By using the wide paper a print $17\frac{1}{8} \times 13$ inches can be secured; allowing for trimming, plates or printed pages up to $16\frac{1}{2} \times 12$ can be taken natural size. The large size machine can be set to wind off automatically 9 or 18 inches of paper and the smaller one $7\frac{1}{2}$ or 15 inches.

By a new attachment devised by the junior author it is possible to wind into place 36 different lengths of paper, varying from one-half to 18 inches, so it is easy to set the machine to make the most economical use of the sensitized paper in photographing a book, plate or map. A special frame that comes with the machine permits the book to be held in a horizontal position and the image is rectified by passing through a right-angled prism which corrects the reversal of the image due to the photographic lens. Consequently a direct exposure gives a negative as to color, i.e. white letters on black background, but a positive as to position, i.e. the print can be read directly from the face of the paper. This permits the use of such a direct image or negative for reproducing printed or written matter.

The commercial uses of the photostat are usually limited to negative prints, i.e. letters, specifications, diagrams, drawings, etc., are reproduced in white on a black ground. Such negative prints are very useful for reproducing a single page or a few pages of a publication and may sometimes be used in photographing botanical specimens. If several copies are required, all that needs to be done is to make several exposures without changing the position of the book or specimen.

One drawback to such copies is that the black background prevents notes or corrections being added with pencil or pen. Even red ink does not show up well on the black ground. (Chinese vermilion ink that is ground on a slab like india ink makes a very good mark, and liquid white ink may be used.)

By photographing the negative print again a positive is secured which has black letters on a white ground. Such a copy can be annotated as easily as the original, which it is often desirable to preserve intact. By using positive prints pasted back to back it is possible to make very good copies of printed works that look remarkably like the original work. In all cases where positives are made a negative copy is also available. These negatives can be

bound up by perforating them so they can be tied into a pamphlet holder or a special binder made to fit them. They are then available at any time for making additional positive copies. It is sometimes desirable to make the negatives natural size, whereas the positive can sometimes be reduced in size to advantage, making a more convenient volume.

It frequently happens in copying old, more or less discolored, books or manuscripts that it is necessary to use a color screen and make long exposures to secure good negatives. Such negatives when once secured can, however, be copied into positive prints very rapidly. Moreover, the copying of negatives is always easier than making prints from the original book, since it is not necessary to open the frame and adjust the pages as with the book.

In general it would seem desirable to preserve the original negatives in the library and to make positive prints for the use of investigators. If, in addition to the cost of making the positive copy, say one-tenth of the cost of making the original negatives is charged to the investigator, in the long run the libraries will get back the initial expense of making negatives and at the same time supply to students positive copies more cheaply than negatives can be furnished. Such positives have the advantage of reproducing properly any illustration that may accompany the text. Only simple line drawings or mechanical diagrams appear equally well on the negative and positive copies. All complicated illustrations and especially all photographic process illustrations are difficult to understand or use in the negative copy. Furthermore, notes can easily be made on the white surface, whereas negative prints can only be annotated by using white ink or Chinese vermilion.

In copying works printed in non-European alphabets not to be found in the ordinary printing office and not capable of being typewritten, the photostat is, of course, invaluable. It has been found to be particularly useful in handling Chinese works on agriculture and botany. On ac-

count of the scarcity of translators it is often necessary to send such material to China or Japan to have it translated or abstracted. The photostat makes it easy to do such work cheaply. In the copying of ancient manuscripts the photostat method is absolutely necessary to secure accuracy. By using this machine, such copies can be made at very reasonable cost.

Having formerly used glass plates for reproducing rare books, we are in position to know from experience not only the heavy cost of such a method but also the great difficulties in filing in a safe and convenient manner the heavy and easily breakable negatives.

Photostat negatives are merely sheets of flat paper and if properly bound may be used for reference if the original work or the positive copy is not at hand.

We have found that in order to keep the operating cost of the photostat low per unit of work it is necessary to keep the machine in continuous use during at least five or six working hours each day, thereby permitting an economic utilization of the operator's time and of the chemicals used for developing. In this way we have found that the total cost may be kept down as low as $4\frac{1}{2}$ cents per photostat print $7\frac{1}{2} \times 11$ inches.

Although it is a fact that even a beginner can get some sort of results with the photostat, it is nevertheless true that a considerable degree of skill is necessary to enable an operator to get the best results, especially in copying old or discolored books or manuscripts and in making first-class positive copies. It is well worth while for librarians having such work done to insist upon a high standard of excellence in photostat copies. In this way, without materially increasing the cost, a superior grade of work can be obtained.

Utilization of Photography in Botanical Researches

Besides these obvious uses in reproducing rare or costly manuscripts or printed books and articles, we have found the photostat very useful in other ways.

In our work on crop plants and par-

ticularly in the study of the citrus fruits and their wild relatives, we have found it necessary to have at hand the original descriptions of hundreds of different species and also notes as to their uses in their native countries, etc. These descriptions and notes are, of course, scattered through many hundreds of volumes and even though one might happen to be so extraordinarily fortunate as to have within reach a library containing *all* of the books needed, it is not a simple matter to have a dozen or more descriptions from as many different books immediately before one for comparison.

Our citrus index comprises descriptions of more than twenty genera, each one of which has a number of species; in addition there are copies of numerous illustrations. Yet all of this material is contained in one filing drawer and is immediately accessible for consultation and comparison.

In addition to this file we have made up booklets in cases where accounts and discussions of several species are included in one work. The title page of the book is included in these booklets and an index of the species to be found in the photostat copy is bound in at the front of the booklet. In this way we have a small citrus library of our own containing the material on this special subject which is scattered through hundreds of volumes, many of them so bulky or so rare that they are practically inaccessible for daily use.

We have found it possible to use to advantage the large size machine in making copies of valuable herbarium specimens which we cannot retain in our own collection. These prints are made on glossy finish paper which gives a print somewhat like that from a glass plate. In many cases the type specimens of plants are too precious to be consulted except for very critical work. For all ordinary purposes the photostat print suffices.

Instances of the Use of Photography in Library Research Work

One of the most important uses of the method outlined above is to supply missing numbers of periodicals or missing pages

from valuable books. It has been possible for us to complete in this way a number of very important old works on natural history and in one case a series of 61 dissertations of the University of Upsala, Sweden, published from 1787 to 1827, constituting a catalogue of the Natural History Museum of Upsala, a collection of unusual importance because it contained many specimens collected by Linnaeus or his pupils upon which the scientific names now current all over the world were based. No American library had a complete set but by using the photostat two complete sets were made up, one for the Library of Congress (51 original, 10 photostat copies) and one for the New York Botanical Garden (59 original, 2 photostat copies). A memorandum bound in the Library of Congress copy shows where each original was found (they came from four public libraries and one private collection) so that in case of special investigations involving the quality of paper or ink, the original could be found and consulted.

A more extensive piece of work is the making of a photostat copy of an entire book, as was done with Osbeck's *Dagbok öfwer en Ostindisk Resa*, Stockholm, 1757. Only one copy of this work could then be located in this country. Since it was very important for our work we borrowed this copy and made one negative and two positive copies of it. The original negatives are filed in our office, one positive copy is filed in the library of the Department of Agriculture and the other positive copy is now available for field use so that an explorer traveling in China may consult the descriptions of plants that were written more than one hundred and fifty years ago by Osbeck, a pupil of Linnaeus, who was the first botanist to assign modern scientific names to Chinese plants.

Another instance showing the importance of photographic methods in reproducing an entire book is that of the original account of a new and virulent disease of sugar cane and maize that appeared six years ago in Formosa. A bulletin issued by the Sugar Experiment Station of the Formosan

Government in December, 1911, consisting of some 80 pages and 9 plates gave a full description of the new parasitic fungus causing the disease. It was not found in any library in Washington and was finally borrowed from the library of the Sugar Planters' Experiment Station at Honolulu, Hawaii. The entire bulletin and plates were copied by the photostat and largely because of the information thus secured it has been possible for the Federal Horticultural Board of the Department of Agriculture to put into effect quarantine regulations which it is believed will effectively prevent the introduction into this country of this dangerous maize parasite which if once introduced might easily cause a hundred million dollars a year damage to the corn crop of the United States. As the bulletin in question contained maps, photogravures, lithographic plates, and was, moreover, written in Japanese, it would have been impracticable to copy it at any reasonable cost in any other way than by photography.

Every Book and Manuscript in the World Placed Within the Reach of the Investigator by Photographic Means

It often happens that important investigations on critical matters involving interests into the tens or even hundreds of millions are delayed for years because of the lack of books which are known to exist in Old World libraries. Often these books are rarely or never put on the market, practically all of the copies being in the possession of museums, libraries and other public institutions. Under such circumstances it seems the part of wisdom to make definite arrangements by which photographic copies can be secured promptly of all works believed to be of importance for scientific or economic investigations in progress in this country. It is believed that any objection the librarians might feel to having photographic copies made of their treasures would be removed by delivering to the library furnishing the work to be copied a complete photostat copy of it. This could be circulated to readers in

place of the original copy which could be kept under lock and key and only consulted on critical matters. In this way the use of the photostat would not only result in the wider diffusion and greater use of rare books but also in the better preservation of the originals from which the photographic copies were made.

In view of the difficulty, often impossibility, of purchasing old foreign books it becomes evident that in the photostat we have a cheap and efficient means of reproducing quickly such works as are needed by American investigators. It will be necessary to place a photostat in one or more favorably situated cities in Europe and then copy such books and papers as they are needed.

We often forget that European investigators have access not only to the books of their own libraries but to those of foreign countries either by exchange or by a few hours railway travel. The English and French investigators for example, have access to the national libraries of France, Belgium, Holland and England and by a railway journey not exceeding eight to twelve hours' duration. In order to give our investigators facilities equal to those of western Europe our great libraries should be very much more complete than those of London, Paris and Berlin, not, as is actually the case, much less complete. The only feasible way to supplement our scanty library facilities is to use modern scientific and business methods to make available the books of the Old World until we are able and willing to purchase copies. In the case of manuscripts of which often only a single copy exists it is obvious that the photostat will be invaluable for making cheap copies.

There is no longer any need for any competent scholar to be hampered for lack of material provided arrangements are made to install photostats in Old World library centers.

Finally the need of the isolated worker in our own country can be met by furnishing him with photographic copies of the literature he cannot consult in his state.

Possibly if the original user were charged a fifth or a tenth of the cost of such a copy enough other copies could be sold to make the work self-supporting in a short time.

If American scholars are to take the place in the learned and scientific world to which their energy, originality and intelligence entitle them steps must be taken to free them from the heavy handicap they now suffer in competition with their Old-World colleagues because of the greater volume of old books and records at the disposal of the European scholars.

APPENDIX: NOTES ON THE SPECIMENS OF PHOTOSTAT WORK EXHIBITED

1. (a) Negative photostat copies on loose sheets, such as are used in commercial work.

(b) Positives made from such negatives.

2. (a) Negative prints in loose-leaf binders. In the case of material of which it may at any time be desirable to make extra copies, the negatives are made natural size, perforated at the margin, and preserved in these binders so as to be available for making positive copies.

(b) Positives made from these negatives.

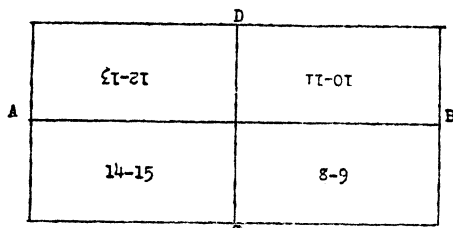
3. (a) Negative prints trimmed and rearranged for use in reproducing books. In the case of books that open flat it is often cheaper and quicker to make a print of two pages at one exposure. These can then be cut apart and tipped on large sheets of black paper in reverse order. When the positive is made it can be folded in the middle with the two blank sides pasted together; the pages will then follow in the same order as in the original book.

(b) A positive copy made from such negative.

4. A book (Osbeck, *Dagbok öfwer en Ostindisk Resa*, Stockholm, 1757) in positive photostat copy, one-fourth natural size, made as described below:

If the negatives show large clear print, four negatives, each of two pages, can be

placed at once in the frame under the lens and a reduced positive copy made on a single sheet. For example, pages 8-15 of a book would be arranged thus:



The resulting positive is folded first on the line A-B and the blank sides pasted together. Then the pasted sheet is folded on the line C-D; turning the double page 14-15 under, leaving the double page 8-9 on top. If the book is bound with guards, such a folded sheet, carrying 8 pages of the original work, can be attached to the stub by a single strip of linen which greatly reduces the work of binding.

5. (a) Negative prints stapled or sewed into a booklet without being pasted. These are useful for reference work and notes can be made on the blank side of the print.

(b) Positive prints made up into a booklet in the same way.

6. (a) Negative prints with the blank sides pasted together bound into a booklet. These small booklets resemble the original book from which they are made except that black and white are reversed. Positives pasted and bound in the same way make notations in the text easier. If bound with each sheet guarded these books open flat and are often easier to use than the original.

7. (a) Negative prints of herbarium specimens, on glossy paper, $16\frac{1}{2} \times 11\frac{1}{2}$

inches. Prints of this kind, made natural size, are very useful when the original specimen is not available for study.

They can be made for a small fraction of the cost of bromide enlargements from glass negatives.

8. Photostat cards and booklets from the Citrus index. A sample showing method of handling and indexing literature relating to the cultivated species of Citrus and their wild relatives. This index comprises loose sheets, filed alphabetically, giving the original descriptions of about twenty genera of the orange sub-family of plants, having from one to fifty or more species; in addition there are photostat copies of numerous illustrations. Besides these loose sheets there are about two hundred booklets made up from individual books, monographs, and local floras, which contain accounts and discussions of several species.

9. Photostat copy of index of Chinese botany. The *Chih wu ming shih t'u k'ao* by Wu Ch'i chün, the best modern work on Chinese botany, comprises 60 volumes but has no index and no general table of contents, though one is given at the beginning of each volume. These tables of contents of the individual volumes were copied with the photostat, the page references added and the whole bound together, which greatly facilitates looking up any particular plant in the text. This piece of work could scarcely have been done at all without using the photostat.

10. Card index of Chinese plant names. Extra copies of the tables of contents of the Chinese botany noted above were made and the plant names occurring in the work pasted on cards, obviating the difficulty and expense of writing these Chinese characters.